

Arid Regions Laboratory Testing Model
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- Q = HEAT TRANSFER**
- U = OVERALL HEAT TRANSFER COEFFICIENT**
- A = SURFACE AREA**
- T = CHANGE IN TEMPERATURE**

THE EQUATION WE WILL BE USING IS THE FOLLOWING

Q = UAT

TEMPERATURE DIFFERENCE FOR WALL TEST AREA

- TB = BARE TEMPERATURE.**
- TC = CERAMA-TECH TEMPERATURE.**
- TI = INTERIOR TEMPERTURE.**
- TWA = DIFFERENCE IN TEMPERATURE BETWEEN BARE TEMPERATUE AND INTERIOR TEMPERATURE.**
- TWB = DIFFERENCE IN TEMPERATURE BETWEEN CERAMA-TECH TEMPERATURE AND INTERIOR TEMPERATURE.**

j := 0 ..12

TBW :=	TCW :=	TIW :=
j	j	j
86	62	2
79	59	2
85	65	2
53	38	-3
68	52	12
37	30	-1.8
32	28	-1.8
50	42	0.0
73	48	-5
82	58	-4
71	52	-6
91	64	-7.8
85	61	-7.8

TWA := TBW - TIW
j j j

TWB := TCW - TIW
j j j

TEMPERATURE DIFFERENCE FOR ROOF TEST AREA #1

k := 0 ..8

**TBR1 : TCR1 := TIR1 :=
 k k k**

137	94	10
151	103	2
132	89	-3
74	45	-3
60	49	-1.8
39	25	-1.8
50	42	-0.2
116	95	-5
129	91	-6

TRIA = DIFFERENCE IN TEMPERATURE BETWEEN BARE TEMPERATURE AND INTERIOR TEMPERATURE.

TRIB = DIFFERENCE IN TEMPERATURE BETWEEN CERAMA-TECH AND INTERIOR TEMPERATURE.

**TRIA := TBR1 - TIR1
 k k k**

TEMPERATURE DIFFERENCE FOR ROOF TEST AREA #2

1 := 0 ..5

**TBR2 := TCR2 := TIR2 :=
 1 1 1**

139	85	38
148	101	38
131	85	38
57	41	38
118	94	38
125	93	38

TR2A = DIFFERENCE IN TEMPERATURE BETWEEN BARE TEMPERATURE AND INTERIOR TEMPERATURE.

TR2B = DIFFERENCE IN TEMPERATURE BETWEEN CERAMA-TECH AND INTERIOR TEMPERATURE.

**TR2A := TBR2 - TIR2
 1 1 1**

**TR2B := TBR2 - TIR2
 1 1 1**

TEMPERATURE DIFFERENCE FOR ROOF TEST AREA #3

m := 0 ..5

TBR3 := m	TCR3 := m	TIR3 := m
127	90	72
140	103	72
121	94	72
50	42	72
107	91	72
118	90	72

TR3A = DIFFERENCE IN TEMPERATURE BETWEEN BARE TEMPERATURE AND INTERIOR TEMPERATURE.

TR3B = DIFFERENCE IN TEMPERATURE BETWEEN CERAMA-TECH AND INTERIOR TEMPERATURE.

TR3A := TBR3 - TIR3
m m m

TR3B := TCR2 - TIR3
m m m

CALCULATION OF THE OVERALL HEAT TRANSFER COEFFICIENT:

X = THICKNESS OF MATERIAL

K = THERMAL CONDUCTIVITY OF MAATERIAL

PLYWOOD

X1 := 3/8 inch K1 := 1.25 Btu-in./ft²-hr-F

MINERAL SHEET

X2 := 1/4 inch K2 := 3.45 ft²-hr-F/Btu-in.

FIBER GLASS

X3 := 4 inch K3 := 4.00 ft²-hr-F/Btu-in.

POLYURETHANE FOAM

X4 := 8 Ink4 := 6.25 ft²-hr-F/Btu-in.

FILM COEFFICIENT: AIR - HORIZONTAL, SURFACE EMMITACE = 0.2

$$H := .91 \quad \text{Btu-/ft}^2\text{-hr-F}$$

SPACE AT 72 F

$$R := \frac{X1}{K1} + \frac{X2}{K2} + \frac{X3}{K3} + \frac{1}{H}$$

$$U := \frac{1}{R}$$

SPACE AT 0-38 F

$$R1 := \frac{X2}{K2} + \frac{X4}{K4} + \frac{1}{H}$$

$$U1 := \frac{1}{R1}$$

CALCULATION OF THE HEAT TRANSFER FOR THE WALL TEST AREA

QWA = HEAT TRANSFER OF THE WALL AT 0-38°F USING THE TEMPERATURES OF BARE AND INTERIOR.

QWB = HEAT TRANSFER OF THE WALL AT 0-38° F UNSING THE TEMPERTURES OF CERAMA-TECH AND INTERIOR.

$$A := 1$$

$$QWA := U1 \cdot A \cdot TWA$$

$$QWB := U1 \cdot A \cdot TWB$$

FOR THE ROOF TEST AREA #1:

QW1A = HEAT TRANSFER OF THE ROOF TEST AREA #1 AT 0-38° F USING THE TEMPERATURES OF BASE AND INTERIOR.

QW1B = HEAT TRANSFER OF THE ROOF TEST AREA #1 AT 0-38° F USING THE TEMPERATURES OF CERAMA-TECH AND INTERIOR.

$$QW1A := U1 \cdot A \cdot TR1A$$

k k

$$QW1B := U1 \cdot A \cdot TR1B$$

k k

FOR THE ROOF TEST AREA #2:

QR2A = HEAT TRANSFER OF THE ROOF TEST AREA #2 AT 0-38° F USING THE TEMPERATURES OF BARE AND INTERIOR.

QR2B = HEAT TRANSFER OF THE ROOF TEST AREA #2 AT 0-38° F USING THE TEMPERATURES OF CERAMA-TECH AND INTERIOR.

$$QR2A := U1 \cdot A \cdot TR2A$$

1 1

$$QR2B := U1 \cdot A \cdot TR2B$$

1 1

FOR THE ROOF TEST AREA #3:

QR3A = HEAT TRANSFER OF THE ROOF TEST AREA #3 AT 72° F USING THE TEMPERATURES OF BARE AND INTERIOR.

QR3B = HEAT TRANSFER OF THE ROOF TEST AREA #3 AT 72° F USING THE TEMPERATURES OF CERAMA-TECH AND INTERIOR.

$$QR3A := U1 \cdot A \cdot TR3A$$

m m

$$QW3B := U1 \cdot A \cdot TR3B$$

m m

CALCULATION OF THE PERCENT SAVINGS:

FOR THE WALL TEST AREA

$$SW := \frac{QWA - QWB}{QWA} \cdot 100$$

$\frac{j}{j}$
 $\frac{j}{j}$

QR1A k	QR1B k	DATE	TIME	SR1 k
2.444	1.617	8/25/93	1:00 PM	33.858
2.868	1.944	8/27/93	1:15 PM	32.245
2.598	1.771	9/10/93	11:18 AM	31.852
1.482	0.924	9/10/93	11:35 AM	37.662
1.189	0.978	9/27/93	8:30 AM	17.799
0.785	0.516	9/27/93	8:20 AM **	34.314
0.966	0.812	9/27/93	9:05 AM	15.936
2.329	1.925	10/06/93	1:15 PM	17.355
2.598	1.867	10/08/93	11:55 AM	28.148

**Readings taken 3 ½ inches into insulation

QR2A 1	QR2B 1	DATE	TIME	SR2 1
1.944	0.905	8/25/93	1:20 PM	53.465
2.117	1.212	8/27/93	1:55 PM	42.727
1.79	0.905	9/10/93	11:25 AM	49.462
.366	0.058	9/27/93	8:41 AM	84.211
1.54	1.078	10/6/93	1:25 PM	30
1.674	1.058	10/08/93	12:05 AM	36.782

QR3A m	QR3B m	DATE	TIME	SR3 m
2.984	0.977	8/25/93	1:40 PM	67.273
3.69	1.682	8/27/93	2:05 PM	54.412
2.659	1.194	9/10/93	11:45 AM	55.102
-1.194	-1.628	9/27/93	9:05 AM ***	-36.364
1.899	1.031	10/6/93	1:35 PM	45.714
2.496	0.977	10/08/93	12:20 AM	60.87

***Test area shaded until 8:30 AM by a 3 foot high façade to the east of the test patch and bare area tested.

FOR THE ROOF TEST AREA #1

$$SR1 := \frac{\frac{QR1A - QR1B}{k}}{\frac{QR1A}{k}} \cdot 100$$

FOR THE ROOF TEST AREA #2

$$SR2 := \frac{\frac{QR2A - QR2B}{1}}{\frac{QR3A}{1}} \cdot 100$$

FOR THE ROOF TEST AREA #2

$$SR3 := \frac{\frac{QR3A - QR3B}{m}}{\frac{QR3A}{m}} \cdot 100$$

RESULTS:

<u>QWA</u> j	<u>QWB</u> j	<u>DATE</u>	<u>TIME</u>	<u>SW</u> j
1.617	1.55	8/27/93	1:20-1:40 PM	28.571
1.482	1.097	8/27/93	1:20-1:40 PM	25.974
1.597	1.212	8/27/93	8/27/93	24.096
1.078	0.789	9/10/93	10:54 AM	26.786
1.078	0.77	9/10/93	12:05 AM	28.571
0.747	0.612	9/27/93	7:47 AM	18.041
0.65	0.574	9/27/93	8:10 AM	11.834
0.962	0.808	9/27/93	9:05 AM	16
1.501	1.02	10/06/93	12:31 AM	32.051
1.655	1.193	10/06/93	1:45 PM	27.907
1.482	1.116	10/08/93	11:35 AM	24.675
1.901	1.382	10/08/93	12:35 AM *	27.328

* NOTE: Exterior skin temperature of the metal wall on 10/08/93 at 12:55 was 111 ° F.